

BMW Group
Media H2 Workshop
Berkeley/LA CA
8-30/9-1, 2005

BMW Clean Energy Vision

Media Hydrogen Workshop



Hydrogen Economy

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BMW Group



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BMW Clean Energy Vision

It can be done!



It can be done...

sustainable mobility...

hydrogen as the energy carrier!

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Six Generations of Hydrogen Cars 1979 to 2005



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What is our Motivation?

- ❖ finite fossil fuel resources
- ❖ reduction of CO₂ emissions
- ❖ energy independence

Short- and mid-term Targets:

Reduction of fuel consumption

Gasoline: e.g. VALVETRONIC
Diesel: e.g. Common-Rail
fuel injection



Long-term Targets :

Development of competitive and sustainable products:

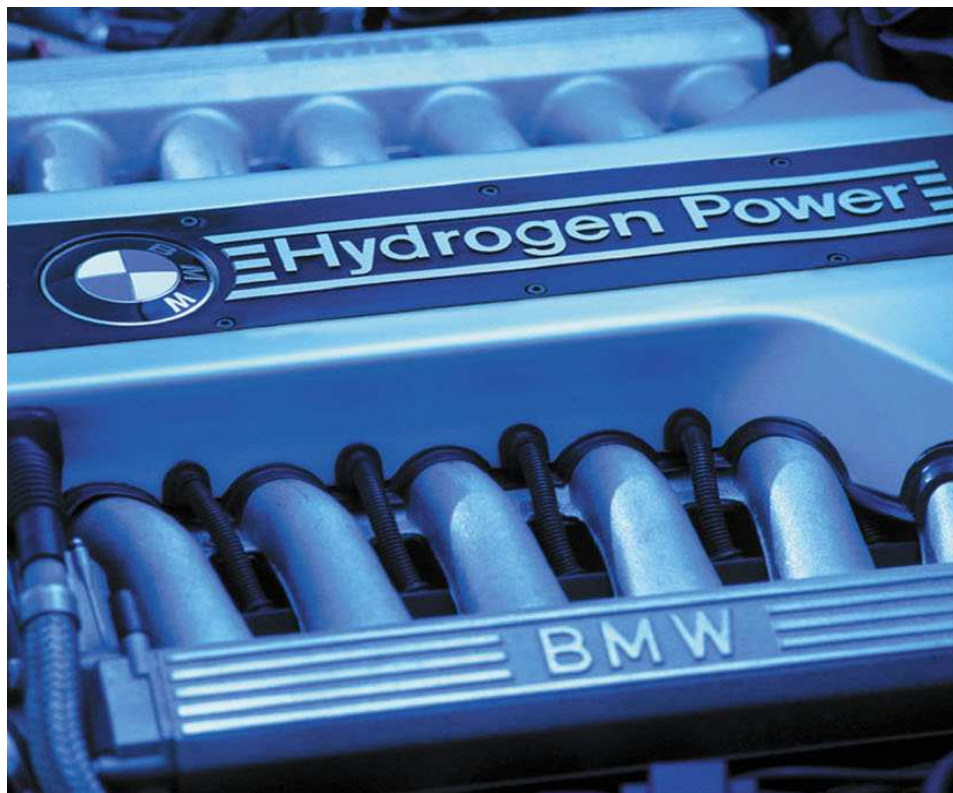
Hydrogen-powered Vehicles



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Why hydrogen internal combustion engine?

Each system should do what it does best...



Hydrogen internal combustion engine...
for propulsion



Fuel-cell auxiliary power unit
(APU) on the vehicle...
for electrical power

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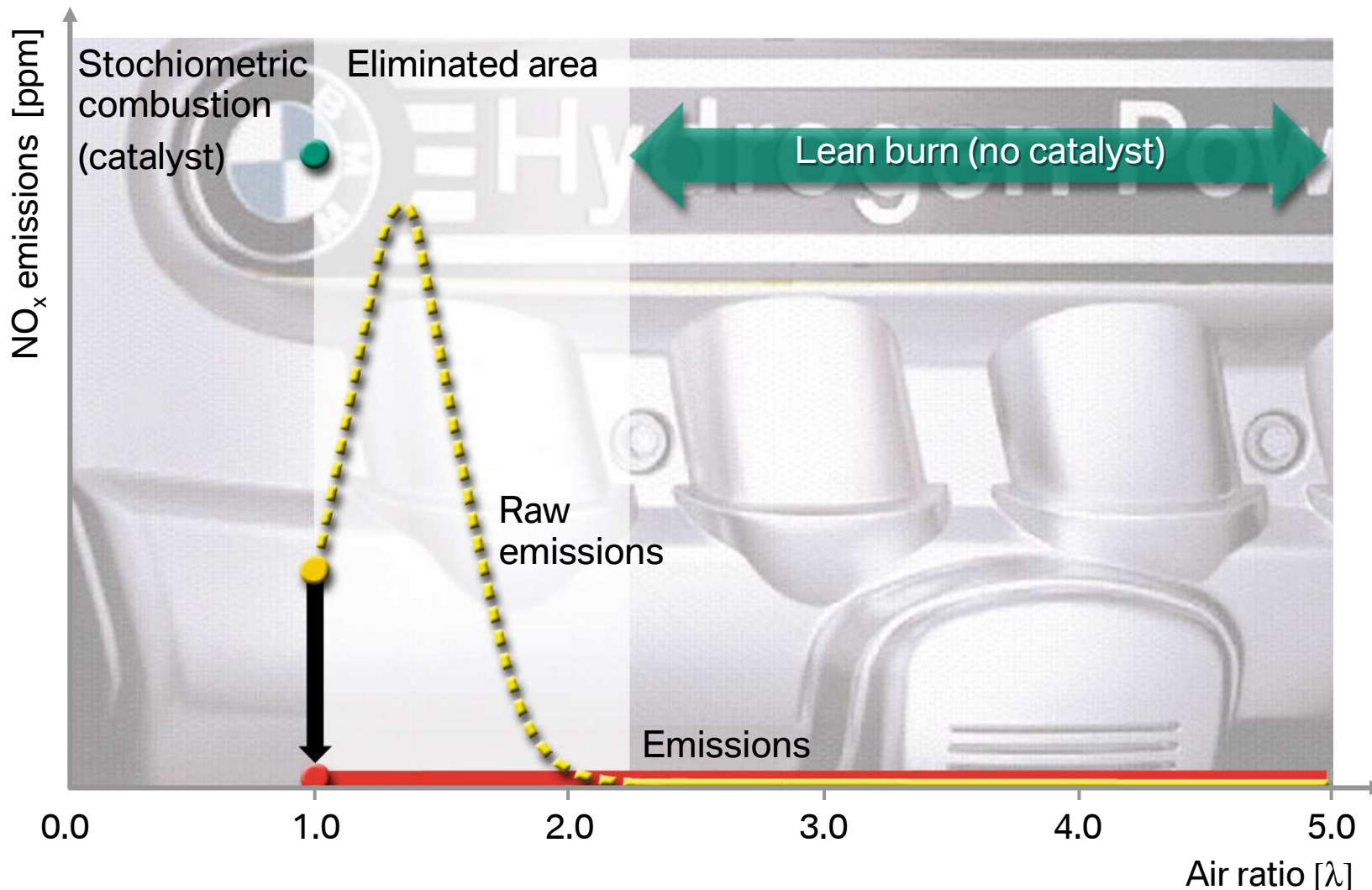
What are the advantages?



- High power density
 - Over 100 years ICE experience
 - Significant efficiency improvement potential
 - Exciting, fun to drive!
-
- Competitive power output
 - Familiar characteristics
 - Cost-efficient / competitive production
 - Bi-fuel or dedicated H2 engine

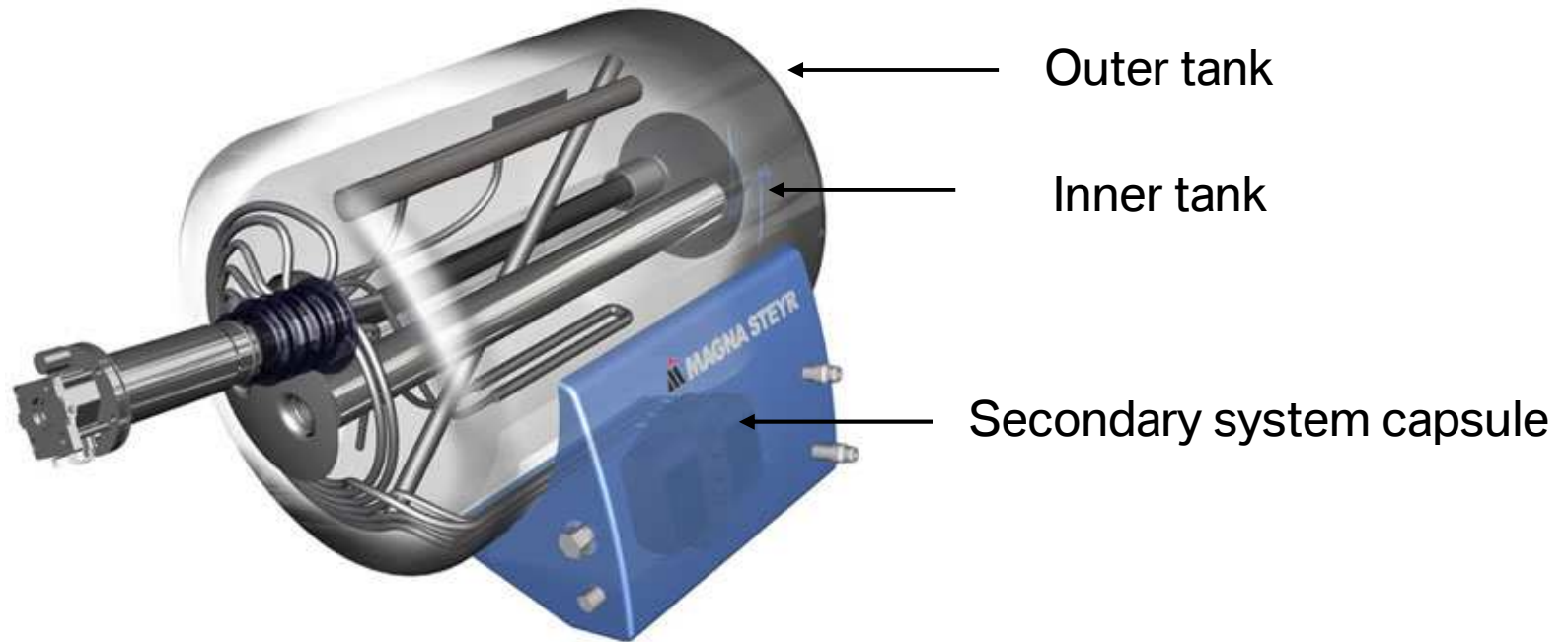
BMW CleanEnergy Vision Near Zero Emission Vehicle

Engine Combustion Concept for H₂ ICE



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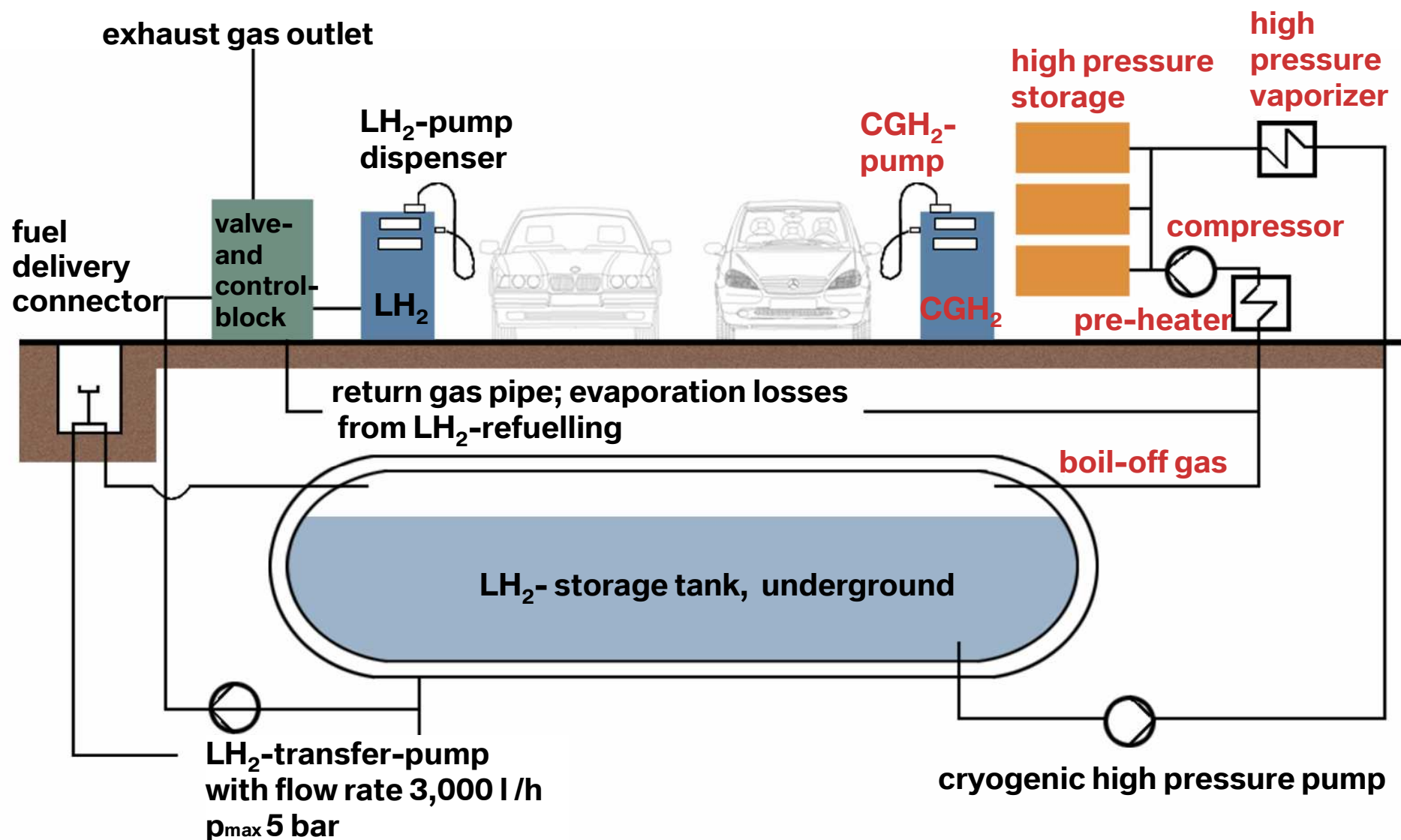
Liquid Hydrogen Concept



- **Storage system LH₂**
- Super insulation
- Challenges → heat transfer
→ boil-off management

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Refuelling Station for LH₂ and CGH₂.



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Clean Energy Partnership – Berlin, Germany



Ford Focus
FCEV-Hybrid

Opel Zafira
HydroGen3

DaimlerChrysler
A-Klasse F-Cell

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H₂-7 Series

Different approaches, common infrastructure!

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We are currently very busy...

Production Development



H2 Engine Research



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Product Development Objectives

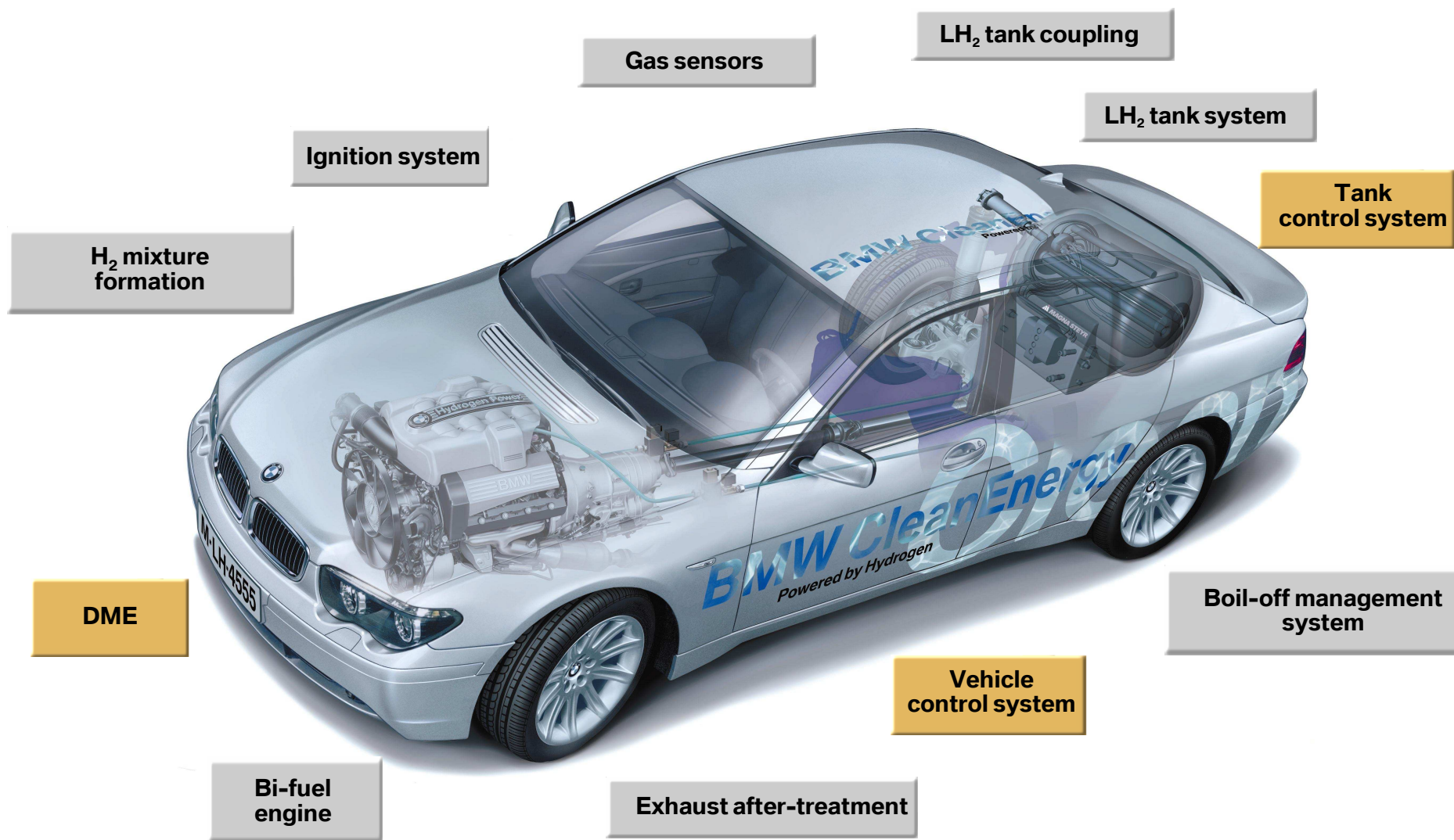


- Reliable operation under all climate conditions
- Adequate service intervals
- Safety in traffic
- Competitive costs compared with traditional gasoline and diesel cars
- Meeting or exceeding customer demands (performance, driving range, ...)

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Assembly and Function of the H₂ 7 Series.



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Safety Concept H₂ 7 Series.

Action taken:

**Gas feed components
absolutely tight**

**Crash-proof
Arrangement of
components**

**External safety
measures**

**No-risk removal of
escaping hydrogen**

**High reliability
tank vacuum**

Safety target:

**Tank, pipes or
components
do not burst**

**No ignitable
mixture
(except in engine)**



**Prevent uncontrolled
gas leakage**

**Supervision and
switch-off of system**

**Closing of
H₂ valve**

**Reliable
boil-off
utilization**

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Testing and Production Validation



Testing during the entire year under extreme environmental conditions:

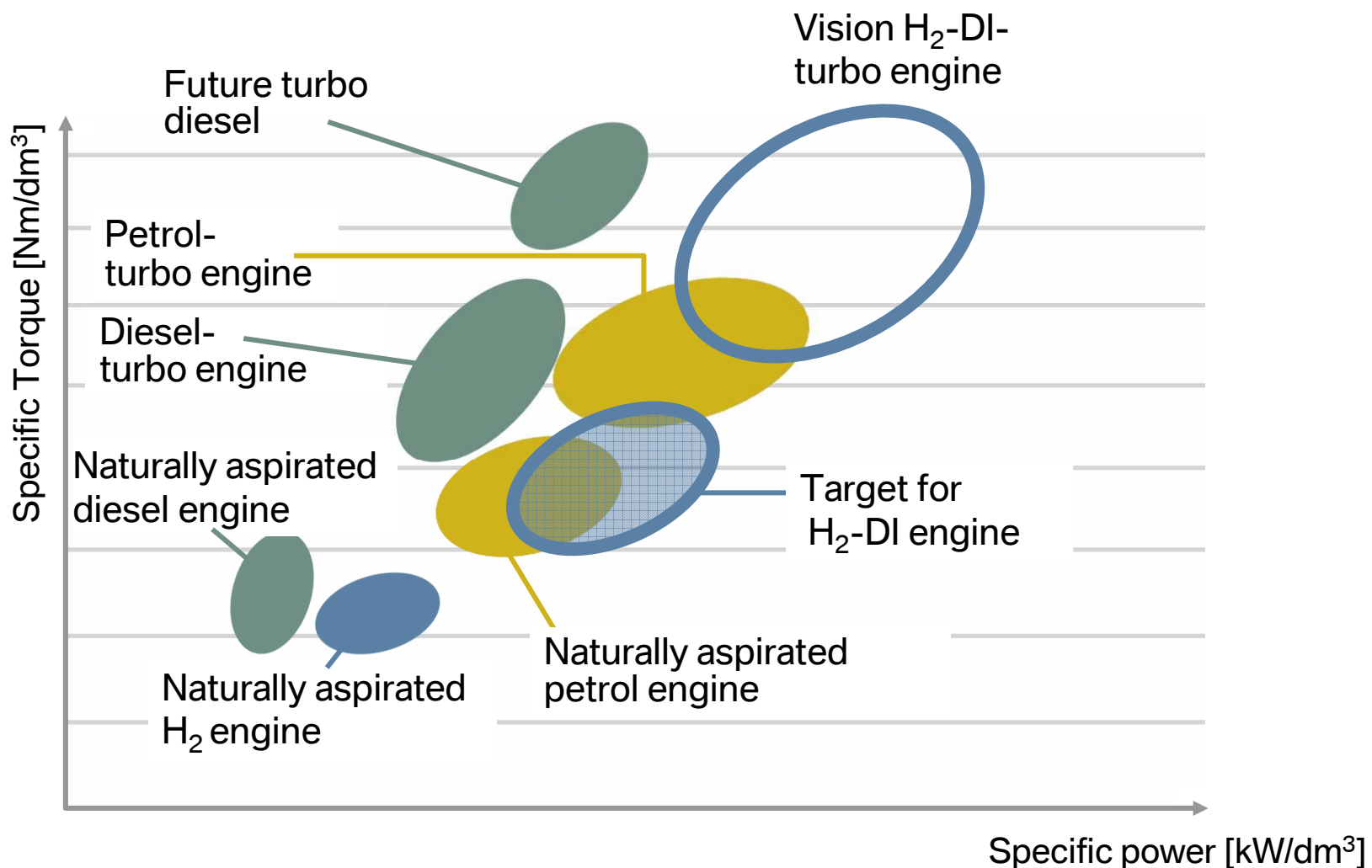
- High speed track tests
- Very cold climate condition tests
- Hot climate tests

➔ Proven for customer use!



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Potentials for ICEs.



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Hydrogen Direct Injection - Ideal Combustion Management

- Combustion process initiated by external ignition
- Combustion process controlled by injection
- Avoidance of knocking
- High engine speeds (high rate of combustion)
- High torque (turbo-charging, better cylinder charge)
- High level of efficiency (high compression ratio, no throttle effects)



This BMW direct hydrogen injection process provides an ideal combination of gasoline and diesel engine combustion qualities...with near zero emissions!

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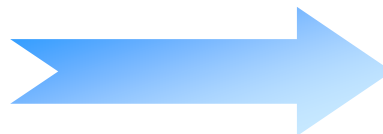
High Power and Efficiency Potential.



BMW H₂R today

**12 Cylinders
6 Liters**

»» 300 bhp



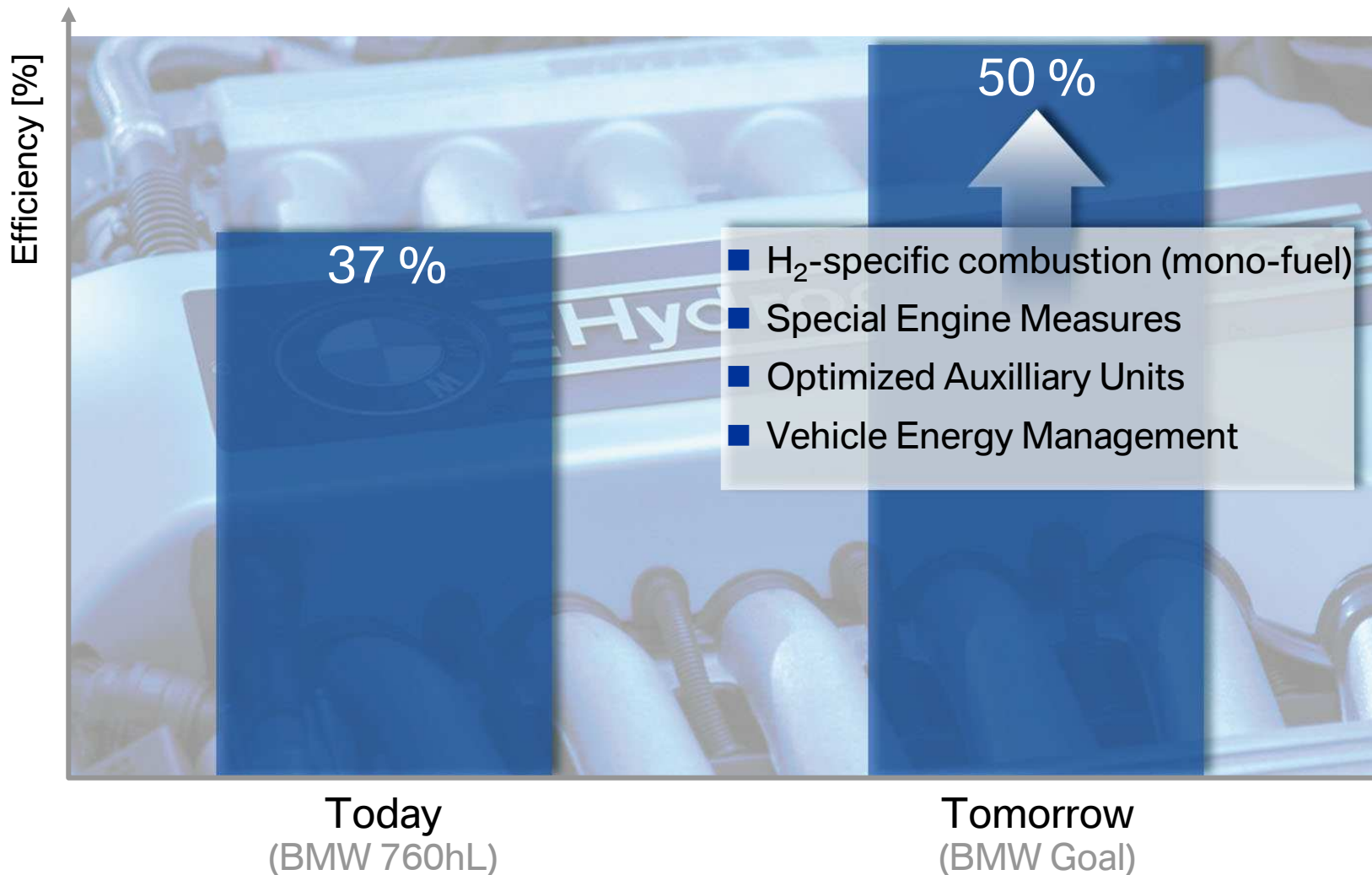
and tomorrow

**4 Cylinders
2 Liters**

»» 300 bhp

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Efficiency of H2 ICE Concepts



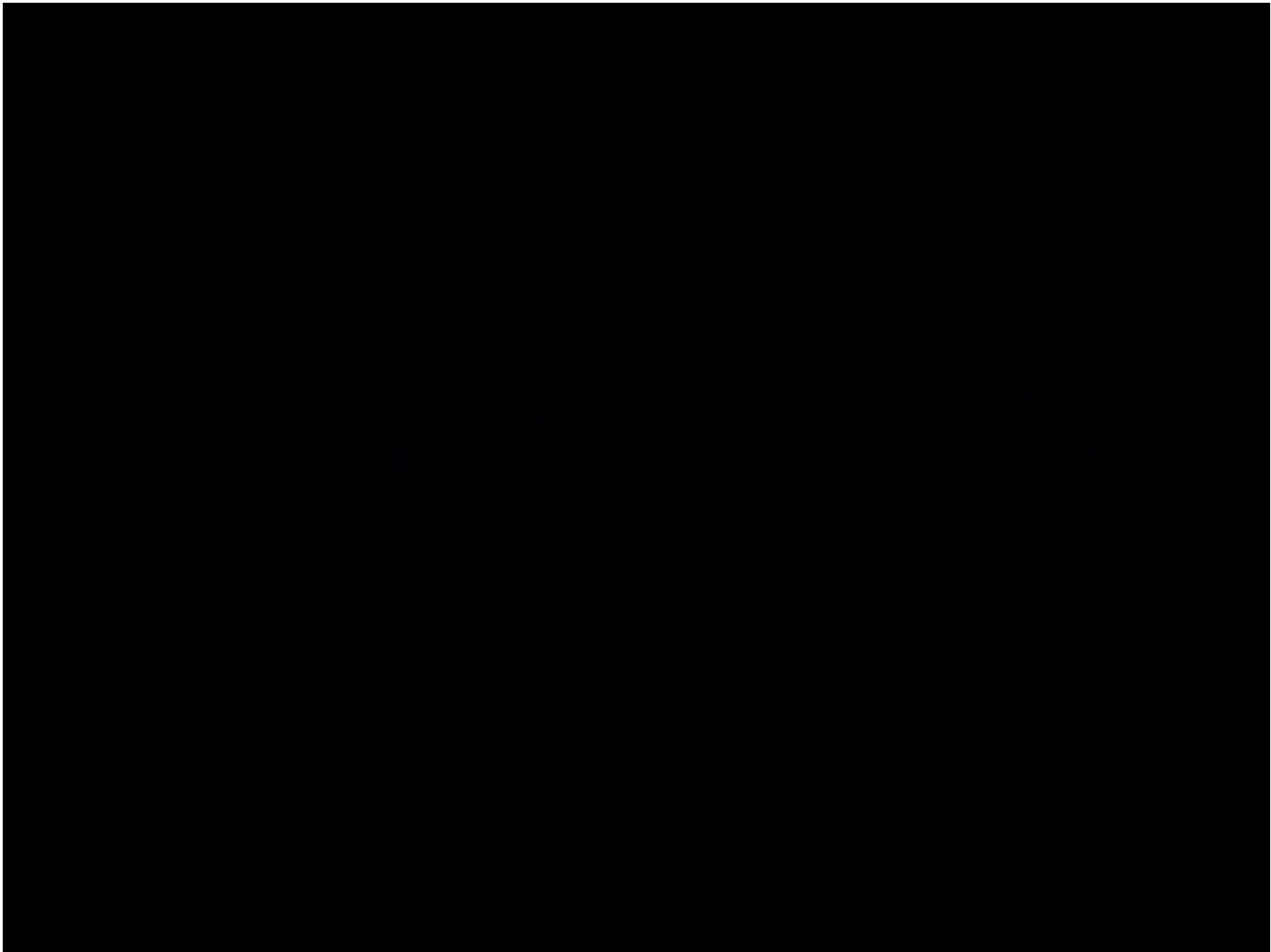
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And what do we do for fun?

BMW H₂R sets Nine Records!





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Summary

- Renewable hydrogen is the only sustainable energy source for the future.
- Hydrogen is the fuel of the future independent of the technical concept (power train, storage).
- The production development of hydrogen cars demonstrates the strong commitment of the BMW Group towards hydrogen.
- To build up the hydrogen economy, alliances between governments, energy providers and the automotive industry are needed.

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For further Information...



Thank you for your attention!

go to:

www.bmwgroup.com/cleanenergy